QUARTERLY REVIEW

OPERABILITY IPT REPORT

KEITH KALINOWSKI

October 9, 1997

QUARTERLY REVIEW
JUNE 1997

I   **OPERATIONS TOPICS**

  - **SEPTEMBER'S FLIGHT SOFTWARE INNOVATIONS WORKSHOP**

  - **ADAPTIVE SCHEDULER PROTOTYPE DEVELOPMENT**

  - **SCIENTIST'S EXPERT ASSISTANT PROTOTYPE**

FLIGHT SOFTWARE
INNOVATIONS WORKSHOP

l **SPONSORED BY THE NGST OPERABILITY IPT, ORGANIZED BY CODE 512, CHAIRED BY ELAINE SHELL, HELD SEPTEMBER 10-11 (1.5 DAYS)**

l **KICK-OFF OF IPT's EFFORTS TO FOSTER ADVANCES IN FLIGHT SOFTWARE (FSW) METHODOLOGIES AND DEVELOPMENT ENVIRONMENTS**
  - **GOAL IS A SIGNIFICANT REDUCTION IN FSW LIFE-CYCLE COSTS**

l **18 INVITED PARTICIPANTS**
  - **10 FROM EXTERNAL INSTITUTIONS (INCLUDING ARCHITECTURE STUDY REPRESENTATIVES)**
  - **8 FROM CODES 500 & 700**

l **MANY MANAGEMENT- AND PROCESS-ORIENTED INPUTS, PLUS IDEAS FOR TECHNOLOGY ENDEAVORS**
  - **IN THE COMING YEAR, THE FORMER WILL BE DOCUMENTED AND THE LATTER WILL BE EXPANDED, FLESHED-OUT AND EVALUATED FOR IMPLEMENTATION**

l **MINUTES**
  - **SENT TO PARTICIPANTS FOR REVIEW AND COMMENT**
  - **WILL BE POSTED ON THE NGST WEB SITE BY 10/31**

FLIGHT SOFTWARE INNOVATIONS WORKSHOP
DRAFT FY98 MILESTONES

- **NOVEMBER - DECEMBER**

  - **EVALUATE CANDIDATE INNOVATIONS FOR RELATIVE PROMISE AND DIFFICULTY**

- **JANUARY - FEBRUARY**

  - **IDENTIFY OPTIONS FOR IMPLEMENTING KEY IDEAS; DRAFT A PLAN**

- **MARCH**

  - **HOLD FOLLOW-UP WORKSHOP TO REVIEW AND ITERATE PLAN CONTENT**

- **APRIL - JUNE**

  - **UPDATE AND FORMALIZE PLAN TO TACKLE HIGHEST PRIORITY INNOVATIONS**

- **SEPTEMBER**

  - **ISSUE *FLIGHT SOFTWARE DEVELOPMENT GUIDELINES* DOCUMENT**

WHAT IS AN "ADAPTIVE SCHEDULER?"

- ADAPTIVE SCHEDULER (AS) ORCHESTRATES EXECUTION OF SCIENCE OBSERVATION PROGRAM

- UPLINKED "SCRIPTS" ARE USED WITH ON-BOARD MACROS TO REPLACE STORED COMMANDS ASSOCIATED WITH ABSOLUTE TIME TAGS

  - SCIENCE TARGET LIST

  - SCIENCE INSTRUMENT CONFIGURATIONS

  - TEMPLATES DEFINING OBSERVATION PROCEDURES AND ENGINEERING ACTIVITIES

- AS AUTOMATICALLY INITIATES NEW SCRIPT ACTIVITY ON COMPLETION OF PREVIOUS SCRIPT ACTIVITY

- THE PACE OF SCRIPT EXECUTION IS GOVERNED BY REAL-TIME EVENTS

  - INITIATION OF NEXT ACTIVITY AT COMPLETION OF PREVIOUS ACTIVITY

  - SKIP/DELETE ACTIVITY DUE TO ANOMALOUS EVENTS

  - RETURN TO PREVIOUS ACTIVITY DUE TO ANOMALOUS EVENTS

  - INSERT SPACECRAFT ACTIVITY BETWEEN SCRIPT ACTIVITIES

    - (E.G., ANGULAR MOMENTUM UNLOADING)

- SUSPEND PROCESSING PENDING GROUND INTERVENTION

ADAPTIVE SCHEDULER PROTOTYPE DEVELOPMENT PLAN

| **PROTOTYPE MAJOR FUNCTIONS:**

- 1. **EXECUTE ADAPTIVE SCHEDULER FUNCTION**

- 2. **EMULATE FLIGHT SOFTWARE FUNCTIONS RELEVANT TO ADAPTIVE SCHEDULING**

- 3. **EMULATE GROUND SYSTEM (SCRIPT GENERATION & MANIPULATION; COMMANDING & TELEMETRY)**

- 4. **ONBOARD FAULT DETECTION AND CORRECTION REQUIRED TO TEST ADAPTIVE SCHEDULER**

- 5. **EMULATE EXTERNAL FLIGHT ENVIRONMENT; EXTERNAL MODELS**

- 6. **EMULATE HARDWARE OUTPUT**

| **GOALS OF STAGE A PROTOTYPE EFFORT:**

- 1. **DEMONSTRATE BASIC ADAPTIVE SCHEDULING CONCEPT**

- 2. **EVALUATE STRAWMAN ADAPTIVE SCHEDULING ALGORITHM BEHAVIOR**

  - **EMULATE ENVIRONMENT INFLUENCING NGST AT L2**

  - **EMULATE ROUTINE OPERATIONS AS ENVISIONED BY OPERATIONS CONCEPT**

- 3. **REFINE STRAWMAN ALGORITHM**

- 4. **ASSESS SCL AS THE APPROPRIATE SCRIPT INTERFACE**

I   **GOALS OF STAGE B PROTOTYPE EFFORT**

-   **1. SUBJECT STAGE A ADAPTIVE SCHEDULER ALGORITHM TO MORE REALISTIC TEST CASES**

    •   **INCORPORATE NGST HARDWARE/ENVIRONMENTAL MODELS AND ALGORITHMS (FROM GARY MOSIER'S GROUP)**

    •   **MODEL PLAUSIBLE NGST MULTIPROCESSOR ENVIRONMENT TO EMULATE POSSIBLE TIMING BEHAVIOR**

-   **2. DEVELOP AND IMPLEMENT IMPROVED ADAPTIVE SCHEDULER ALGORITHM INCORPORATING REMOTE AGENT CHARACTERISTICS**

-   **3. ADOPT AND EXPERIMENT WITH METHODOLOGIES/TOOLS GROWING OUT OF THE FSW INNOVATIONS EFFORT**
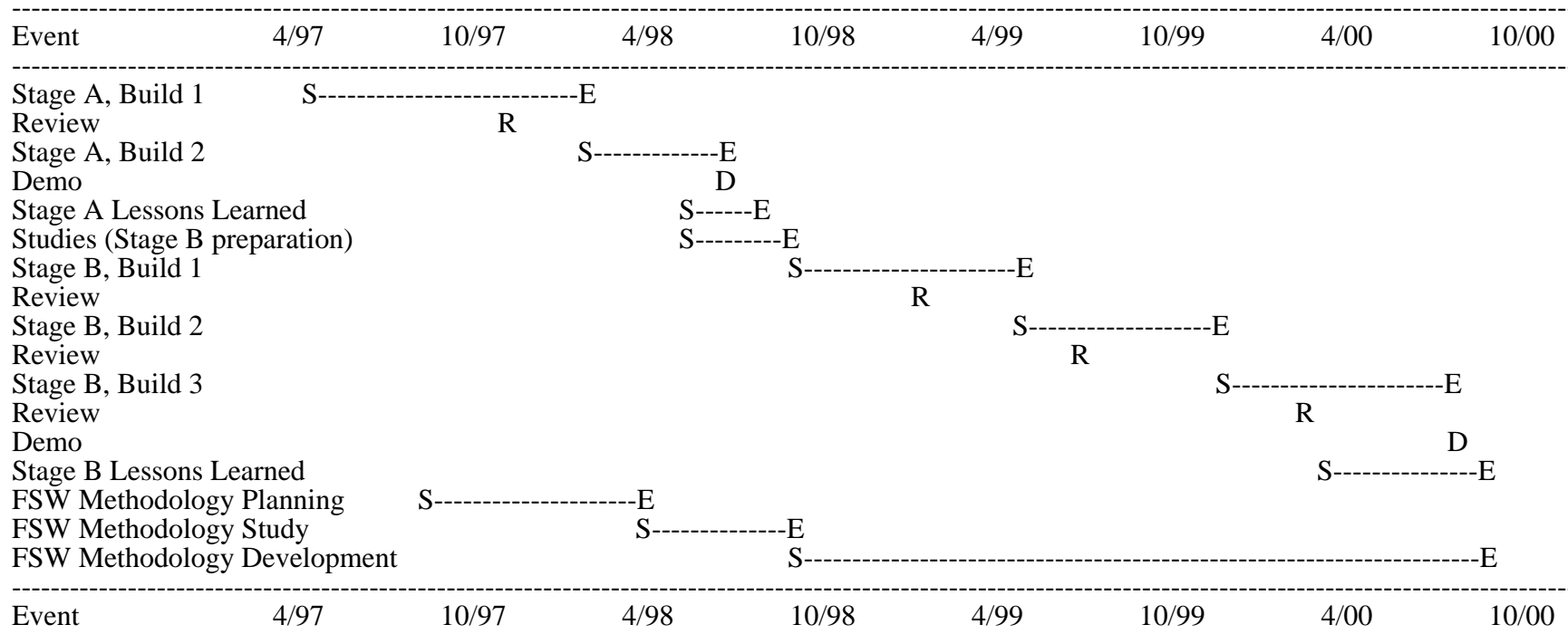
ADAPTIVE SCHEDULER PROGRESS SINCE JUNE QUARTERLY

l   **COMPLETED TEAM TRAINING IN SCL**

l   **HIGH LEVEL DESIGN COMPLETED; SOME IMPLEMENTATION LEVEL DESIGN REMAINS**

l   **COMPLETED C-CODE IMPLEMENTATION OF FSW EMULATION COMPONENTS FOR ACS AND SI PROCESSING**

l   **COMPLETED INITIAL VERSION OF ACTIVITY LIST GENERATION IN JAVA**

HIGHLIGHTS OF ADAPTIVE SCHEDULER PROTOTYPE PLAN

```
---------------------------------------------------------------------------------------------------------------------------
Event                     4/97        10/97        4/98        10/98        4/99        10/99        4/00        10/00
---------------------------------------------------------------------------------------------------------------------------
Stage A, Build 1            S--------------------------E
Review                                  R
Stage A, Build 2                                S------------E
Demo                                              D
Stage A Lessons Learned                        S------E
Studies (Stage B preparation)                  S--------E
Stage B, Build 1                                    S--------------------E
Review                                                    R
Stage B, Build 2                                                    S------------------E
Review                                                                    R
Stage B, Build 3                                                                S--------------------E
Review                                                                                R
Demo                                                                                    D
Stage B Lessons Learned                                                             S--------------E
FSW Methodology Planning    S--------------------E
FSW Methodology Study                         S-------------E
FSW Methodology Development                   S----------------------------------------------------------------E
---------------------------------------------------------------------------------------------------------------------------
Event                     4/97        10/97        4/98        10/98        4/99        10/99        4/00        10/00
---------------------------------------------------------------------------------------------------------------------------
```

Stage A, Build 1
    Strawman Adaptive Scheduler algorithm
    Activity list generator
    Limited FSW emulation and hardware/environmental simulation (primarily ACS and SI)
Stage A, Build 2
    Updated Adaptive Scheduler algorithm
    Limited data display
    Very limited fault detection and correction (primarily ACS and SI)
Studies (Stage B preparation)
    multiprocessor architecture study
    NGST model assimilation
    remote agent concept study
Stage B, Build 1 (testbed redesign/rebuild)
    Software redistribution within multprocessor framework
    Simulation control updates to support multiprocessor framework
Stage B, Build 2 (high fidelity models)
    Incorporation of NGST high fidelity models (subsystem emulation, hardware/environmental models)
    Simulation control updates to support high fidelity models
Stage B, Build 3 (Adaptive Scheduler algorithm with remote agent characteristics)
    Remote agent Adaptive Scheduler
    Look-ahead predictor

FSW Methodology Planning
    FSW Innovation Workshops
    Identification of most promising initiatives
    Detailed plans for each initiative selected
FSW Methodology Study
    Blending of Stage B development plans with FSW methodology development plans (when to introduce new tools, what training
        will be required, tool procurement, etc.)
FSW Methodology Development
    Creation of strawman FSW methodology, with identification/development of associated tools, for evaluation in Stage B
    Tuning of strawman methodology/tools from lessons learned in Stage B development effort

Scientist's Expert Assistant (SEA) Prototype Objectives for FY97 Q4

l **Identify target instrument for prototype work**
  - **Status: HST's ACS**

l **Develop script to understand the interaction between the CS and GO.**
  - **Status: High level understanding is done, more detailed script underway to outline subset of ACS operations for prototyping**

l **Use script and GO/CS interviews to determine best AI paradigm, tools, and methodology**
  - **Status: Combination of rules-based ES tools and visual/graphical interface tools recommended**

l **Develop simple web-based prototype user interface to implement target script.**
  - **Status: Using interactive exposure time calculator as on-line "RAD" user-interface testbed**

SEA Prototype: Primary tools/modules

l **Graphical, "real-time" exposure calculator**

  - Initial prototype tool, reduce over 100 pages of graphs and tables into single interactive screen. Allow changes to target or instrument parameters and see instant affects on source counts, Signal-Noise Ratio, and /or exposure times.

l **"Visual" Target Tuner**

  - Provide graphical approach to fine tuning target coordinates and orientation. Allow user to mark areas specifically for inclusion or exclusion; simulate direction of "spikes" and spectroscopic "bars"; allow user to visually specify orientation ranges.

l **Instrument Configuration Expert System**

  - Rule based system to guide user via science-based questions to recommendations on filters, and other instrument parameters. Also, will integrate context-sensitive cross-references to online manuals.

l **Visit Planner Expert System**

  - Provide guidance for ordering of multiple exposures; assist laying out exposures for region requiring several images as a mosaic; provide database query assistant to help search for multiple targets and then electronically retrieve known information about the selected targets.

l **Re-validation Assistant**

  - Tool or "agent" to automatically scan and analyze impacts to completed or in-process proposals when instrument parameters change.

SEA Prototype, Plans for FY 98:
Begin Proof of Concept

| **Q1:**

- **Internal System Design and Architecture**

- **Prototype exposure time calculator (in Java) for ACS**

| **Q2:**

- **Build 1 Visual Target Tuner**

    • provide initial image, overlay instrument aperture, manipulate through "dragging" aperture location and orientation.

- **Build 1 Instrument Configuration Expert System (with ACS as test-bed)**

    • develop initial user-interface, implemented with a small rules set for ACS filter selection

| **Q4:**

- **Build 2 of Visual Target Tuner**

    • initial support for regions of inclusion and exclusion; initial visual modelling of spiking, bleeding, spectrographic bars.

- **Build 2 of Instrument Configuration Expert System**

    • refine user interface, expand rule set to cover additional ACS parameters.

- **End of FY progress review: re-adjust priorities for FY99**